

**TO:** Zoning Working Group  
**FROM:** Pam Heidell<sup>1</sup>  
**SUBJECT:** Zoning for Flood Resilience  
**DATE:** January 26, 2022

Floodplain maps prepared by FEMA that are used to define flood-prone areas and to prescribe flood mitigation measures are based on historic events, and do not reflect the extent of flooding that may occur as a result of climate change, e.g., more intense precipitation as well as sea level rise. The *Massachusetts Coast Flood Risk Model* is predictive and projects storm surge and sea level rise for 2030, 2050 and 2070: this model serves as the foundation for a number of entities' climate vulnerability analyses.<sup>2</sup>

The model's projected flooding in the Mystic River Basin has bearing on Arlington. As noted in the *Town of Arlington Community Resilience Building Workshop Summary of Finding and Recommendations*:

*"Heavy rainfall and ice/snow storms were identified as the hazards having the greatest direct impact on Arlington in the recent past and at present...Storm surge and sea level rise may have severe long-term impacts on neighborhoods and infrastructure in Arlington. At present sea levels, the Amelia Earhart Dam prevents storm surge from flowing up the Mystic River to Arlington. However, an extreme event could send storm surge over or around the dam due to sea level rise by mid-century. Vulnerable areas of town along Alewife Brook and Mystic River would face increasing risks of flooding as sea level rise continues through the end of the century. Even though Arlington may not be directly impacted in the near-term, planning needs to begin now because solutions will likely take significant time, money, and regional coordination to implement."*

Irrespective of whether or not sea level rise is considered or whether the Amelia Earhart Dam will be hardened and storage provided to prevent flanking around the dam, direct precipitation will increase in both intensity and frequency, affecting stormwater and exacerbating and extending the geographic extent of riverine flooding in Arlington.

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<sup>1</sup> With edits and suggestions by Steve Revilak, Nathaniel Stevens, and David Morgan based on their review of a draft.

<sup>2</sup> The Boston Harbor Flood Risk Model (BH-FRM) was developed by UMASS Boston, the Woods Hole Group, and the University of New Hampshire for the Massachusetts Department of Transportation and Federal Highway Administration and was the basis for efforts by The Climate Ready Boston Project and the City of Cambridge's Climate Change Vulnerability Assessment (CCVA Report). The model projects flooding risks that are not reflected in FEMA floodplain maps. A summary of the BH-FRM model is described in the Mass-DOT-FHWA Climate Resilience Pilot Project attached Question and Answer. Results, as they pertain to Arlington, were addressed in Weston & Sampson's January 20, 2021 memo to the Arlington Land Trust, Figure 10 which is included at the end of this memo's text.

While coastal communities in Massachusetts and elsewhere that are subject to sea level rise and coastal storm surges may be at the forefront in terms of incorporating zoning (and other) measures to provide flooding resilience, measures are being seriously considered in inland communities as well. Efforts of various communities are addressed below, with the intent to present an array of zoning measures for flood resilience that Arlington might consider and further investigate.<sup>3</sup>

## **Cambridge**

Cambridge convened a Climate Resilience Zoning Task Force that met 19 times to develop recommendations for development standards to incorporate into Cambridge's Zoning Ordinance. The City's Climate Change Vulnerability Assessment served as technical foundation for its work. The Task Force proposed that development standards be based on long-term flooding projections and projected flood elevations, rather than FEMA maps and studies which are based on historical events.

The Task Force ultimately recommended the following adjustments to current zoning standards (pg. 18 in draft report is excerpted below):

- Exempt outdoor shade canopies from GFA, setback and open space limitations. This would apply to new construction or alterations where shade canopies are proposed.
- Exempt exterior flood resilience measures (e.g. stairs, ramps) from GFA, setback and open space limitation. This would apply to new construction or alterations where site flood protection measure are proposed.
- Exempt usable green roof areas and rooftop access head houses from GFA and height limitations as of right. This would apply to new construction and alterations where green roofs proposed.
- Allow a compensating increase in height limit (up to 4 feet) if the ground story is elevated up to projected 2070 flood elevation. This would apply to new construction or alterations where site flood protection measures are proposed.
- Exempt basement area from GFA limitations as of right, if protected from flooding below 2070 flood elevation. This would apply to new construction or alterations where site flood protection measures are proposed.

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<sup>3</sup> Flooding resilience through zoning is the focus here, rather than energy efficiency in buildings, stormwater management, and more comprehensive climate resilience actions and strategies in programs undertaken in Cambridge (Resilient Cambridge Plan) and Boston (Climate Ready Boston). Also note that some other aspects of Climate Resilience are already addressed in Arlington's Wetland Regulations, Arlington's Stormwater management initiatives and requirements, and Arlington's energy initiatives.

In addition, it recommended adding two standards to projects applying for Special Permit: 1) submission of a Resilience narrative that includes projections for flood risk, and description of mitigation strategies, including flood protection, heat island mitigation, passive resilience measures and operational preparedness; and 2) adding a Resilience Objective to Citywide Urban Design Objectives that would be used by the Planning Board in its review of Special Permit Applications.

For More Information: *City of Cambridge Climate Resilience Zoning Task Force, Draft Final Report, April 30, 2021.* [https://www.cambridgema.gov/~/media/Files/CDD/ZoningDevelopment/OtherProjects/resiliencetaskforce/20210430\\_crztfdraftfinalreport\\_final.pdf](https://www.cambridgema.gov/~/media/Files/CDD/ZoningDevelopment/OtherProjects/resiliencetaskforce/20210430_crztfdraftfinalreport_final.pdf)

## **Brookline**

After completing a Climate Vulnerability Assessment and Action Plan, Brookline hired Weston and Sampson to assess local bylaws and regulations for opportunities to incorporate climate adaptation and resilience. This was funded through a Municipal Vulnerability Preparedness Action Grant (from the Massachusetts EOEEA). With respect to the Zoning Bylaw, the assessment focused on the Floodplain Overlay District, Land Disturbing Activities and Stormwater Management, Dimensional Requirements.

Recommendations to Maximize Flood Protection included:

- Expand Boundary of the Floodplain Overlay District: include areas with a 0.2% annual chance of flood (500-year Flood zone defined by FEMA).
- Building Access: Consider elevated public and private sidewalks, pathways and connecting structures to improve accessibility during floods.
- Freeboard Criteria: Lowest floor must be elevated two feet above the 500 year floodplain and critical facilities must be elevated three feet above the 500 year floodplain.
- Flood marker requirement: Buildings should show depth of flooding
- Flood Protective Design: All new construction should be designed to recover (Flood resistant design; residential units on second floor or higher; ceiling heights should be 15 feet or higher; onsite energy).
- Emergency Plans: Require public emergency plans that include warning and notification protocols...and procedures for deployment of flood protection measures.
- Stormwater: Designs should maximize stormwater absorption and implement compensatory measures and have approved stormwater management permit and plan and site report detailing impacts on adjacent properties.

The report also recommended design standards for the Floodplain Overlay District that would improve resiliency including open space requirements (minimum 30% of gross lot area or the underlying zoning requirement for open space, whichever is greater); tree canopy (minimum 30% tree canopy cover of the gross lot area in Floodplain Overlay District or description why standard can't be met); cool/green roofs; parking requirements (limit surface parking to 10% of gross lot area and set a maximum and no minimum to allow for more open space; and dimensional setback requirements). A se-

ries of recommendations for Cluster subdivision and estate conversions were also set forth.

For More information: *Town of Brookline Massachusetts Climate Resilience Planning Tools, June 2019* by Weston and Sampson. <https://www.mass.gov/doc/climate-resilience-planning-tools/download>

## Hull

In 2009, Hull adopted a freeboard incentive program to encourage the elevation of flood prone buildings above the FEMA base flood elevation to account for future coastal storm events and sea level rise. The Building Department offers a credit up to \$500 off of permit fees for those who elevate new and renovated structures at least two feet above the highest federal or state requirements. In May 2011, Hull amended its Zoning Bylaw to address other restrictions and better accommodate freeboard. The Zoning Board of Appeals may now grant Special Permits to elevate existing buildings for flood protection. These building may exceed the height limit to provide a maximum of four feet of freeboard.

Hull Zoning Bylaw table of Dimensional Requirements:

B. (a.1). The special permit granting authority may in its discretion issue a special permit allowing new or existing buildings located in Special Flood Hazard Area, as defined in the latest addition of 780 CMR, to be elevated beyond the prescribed height limit to flood proofing said building by meeting or exceeding the flood elevation requirements of said CMR. Building cannot exceed the elevation required to comply with 780 CMR by more than four feet.

(b.1) In FEMA flood zones VE, AO and AE, an attached covered structure to house utilities may be constructed in the side or rear setback of an existing residential building for the purpose of housing utilities that are to be elevated above the base flood elevation as shown the FEMA Flood Map for that building's location. Utilities are defined as and are limited to heating units, water heater and hot water storage, electrical panel,, washer and dryer. The footprint to such structure shall not exceed 50 square feet and it shall not encroach into the side or rear setback more than 50% of the required setback of the structure. Such structure shall be allowed when the Building Commissioner or Zoning Enforcement Officer determines that no other practical space is available in the resident to house the elevated utilities.

For more information: Town of Hull, Bylaws/Zoning, Article V Tables, Section 410-5.1 Dimensional Requirements and intensity regulations, Footnotes to Table. [http://www.town.hull.ma.us/sites/g/files/vyh-lif3286/f/uploads/zbi\\_2018\\_stm\\_0.pdf](http://www.town.hull.ma.us/sites/g/files/vyh-lif3286/f/uploads/zbi_2018_stm_0.pdf)

## **Falmouth**

The Town of Falmouth Zoning Bylaw Town Code chapter 240 2021, limits basements for new residential structures in the floodplain district, and requires non-residential structures be elevated above the base flood elevation or floodproofed. The Base Flood elevation considers wind tide and hurricane surge, and is based on FEMA's Flood Insurance maps.

### Floodplain District:

- a. In new residential structures, there shall be no basement area, and upon the making of a substantial improvement, no new basement shall be installed.
- b. The lowest floor of new and substantially improved non residential structures shall be elevated to or above the base flood elevation level or be flood proofed (as defined in Article 3 Definition) to this level.
- c. New and replacement utility and water facilities shall be located and constructed to minimize or eliminate flood damage.

Also: f. Certification by a professional engineer or architect for flooding proofing measures shall be required.

Falmouth also requires the granting of special permit for alteration of land forms where risk of altering drainage or runoff to the detriment of other landholders to the town, and for nonresidential structures, and historic structures. Per Falmouth Zoning Bylaw, its Special Permit findings must also include:

- the granting of the special permit will not result in increased flood heights, additional threats to public safety, extraordinary public expense, or conflict with existing bylaws;
- the relief granted is the minimum necessary considering the flood hazard.

For more information: *Town of Falmouth Massachusetts Zoning Bylaw Town Code Chapter 240, Articles 1-14, November 2020 (Article 7, Overlay Districts, 240-7.3, Floodplain Overlay District <https://www.falmouthma.gov/DocumentCenter/View/8559/Falmouth-Zoning-Bylaw-Recodification-Clean-Copy-for-April-2021-Town-Meeting>*

## **Boston**

The Climate Ready Boston Initiative recommended a zoning overlay district and resilience guidelines. The zoning overlay district is based on the 1% annual chance flood risk in the year 2070, the Sea Level Rise Base Flood Elevation (SLR-BFE) and Design Flood Elevation (DFE) as projected from the Woods Hole Group Flood Risk Model. The Coastal Flood Resilience Guidelines are intended to advance building adaptation and protection from future flood risks. For six different building types, ranging from single

family homes to mixed-use and general industrial, there are tailored guidelines. Common to all, the guidelines require adding 1-2 feet of freeboard above the SLR-BFE.

In October 2021, Boston amended its zoning code to incorporate recommendations arising out of the Climate Ready Initiative. Article 25A of the Boston Zoning Code establishes a Coastal Flood Resilience Overlay District which goes beyond areas identified in FEMA floodplain maps. Within that district, standards are to be applied to generally larger buildings in the Overlay District (10,000 Square Feet, 20,000 Square feet, additions of more than 15 units, establishment of change of use that changes gross floor area of 50,000 or more SF, or substantial rehabilitation of building or structure having or having after rehabilitation, 100,000 or more square feet). Smaller buildings, though, may elect to comply with the standards. Standards include the following:

- Building Height: height is measured from two feet above SLR-BFE.
- Building Setbacks: projects have allowances to extend into side yard, rear yard and front yard setbacks for structures needed for vertical circulation, such as stairs or ramps to get from the surrounding grade to a higher first floor elevation. Also, there are allowances for side yard and rear yard encroachments to house mechanical systems to ensure they are not located in basements or beneath sea level rise base flood elevation.
- Lot Coverage and Required Open Space: The structures needed for vertical circulation and mechanical systems referenced above are excluded from measurement of lot coverage and open space.
- Limitations on Use Below the SLR-BFE: Uses below SLR-BFE are limited to access or vertical circulation structures; flood prevention measures, storage and parking accessory to non-residential uses. Guideline is to look at SLR-BFE and add either 1' or 2' of freeboard to it, depending upon use or if building is an existing building to be retrofitted or if it is planned.

Projects must include a Resilience Narrative which outlines the Project's approach to climate resilience, addressing a checklist of items to be included in the Report.

Boston's Climate Ready initiative also reports that it is engaged in state level initiatives to update the State Building Code, since like the FEMA maps, the State Building Code does not consider future climate conditions.

For More Information: Article 25A - *Coastal Flood Resilience Overlay District of the Zoning Code of Boston*, and *Coastal Flood Resilience Design Guidelines*  
<https://www.bostonplans.org/planning/planning-initiatives/flood-resiliency-building-guidelines-zoning-over>

## **Other**

MAPC provides a number of Zoning Relief Examples. In addition to Hull's zoning, their webpage notes the following:

- Scituate allows existing structures to elevate to achieve base flood to a maximum height of 50 feet (Scituate 200 Section 100).
- Dennis allows existing structures to exceed height limits for up to 3 feet of freeboard (Dennis 6.7).<sup>4</sup>

The attached memo "Resilience Zoning Mechanisms" found on Cambridge's Climate Resilience webpage, summarizes efforts by some cities outside of Massachusetts to zone for flood resilience efforts, including the City of Norfolk, Virginia. Effective March, 2018, Norfolk's Zoning Ordinance establishes a Coastal Resilience Overlay Zone, which, among other things, requires construction in the 100-year floodplain to be elevated at least three feet above the 100-year base flood elevation and construction in the 500 year floodplain be elevated or flood-proofed to 1.5 feet above the 500-year flood elevation. The ordinance also includes a Resilience Quotient System where different resilient measures are assigned points and new developments are required to meet resilience point values.

A number of reports, prepared jointly by the MAPC and some of its member communities, have proposed Climate Ready Actions, including: "Evaluate all zoning, bylaws, and codes for barriers to improvement for climate resilience measures in the built, natural, and landscape environment (i.e., minimize impervious surfaces, using pervious pavers, minimize parking requirements). As a result, Scituate for example, is studying its rules and requirements and identification of a new overlay high hazard district where further control may be necessary.

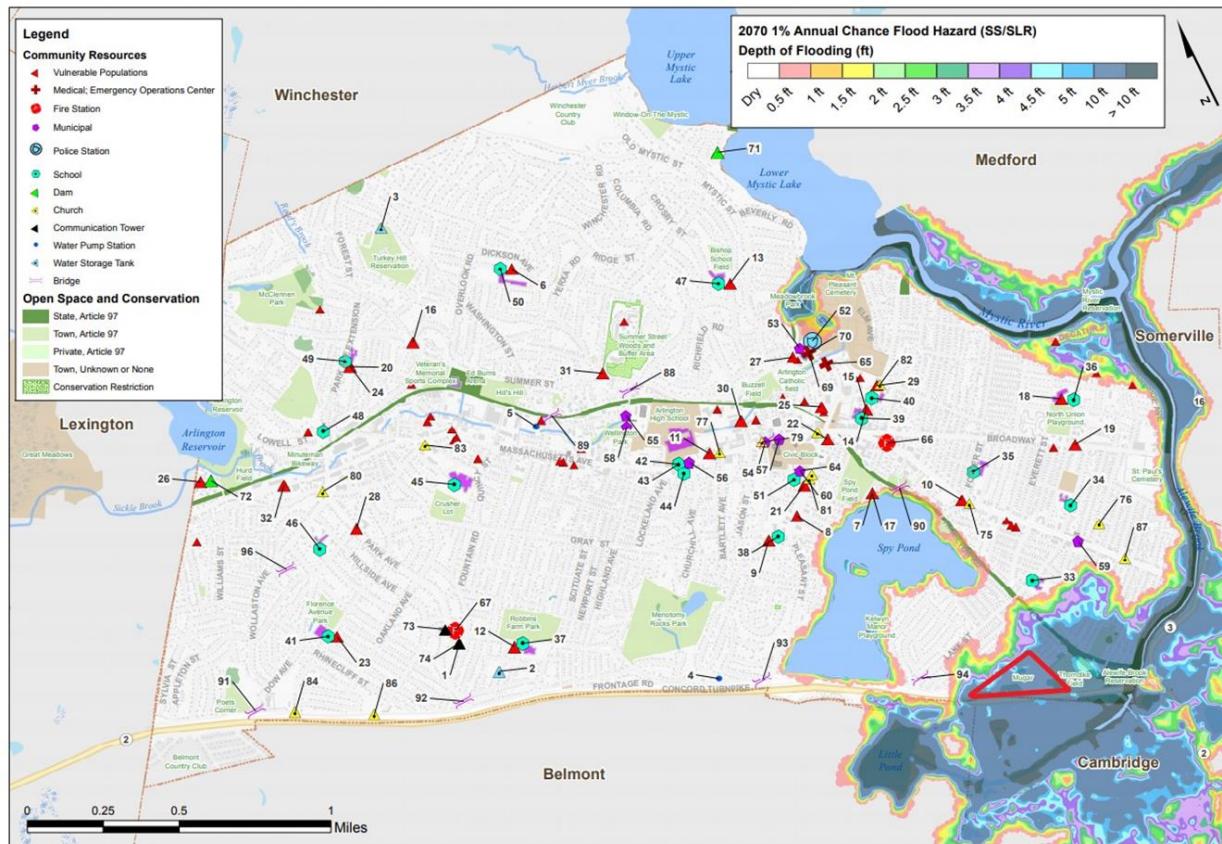
## **Summary**

- Some communities have based, or are planning to base, the boundaries of floodplain districts on detailed modeling of projected flood elevations.
- In lieu of detailed modeling, some communities are contemplating defining the floodplain overlay district based on FEMA's 500-year base flood elevation, rather than the 100-year BFE.

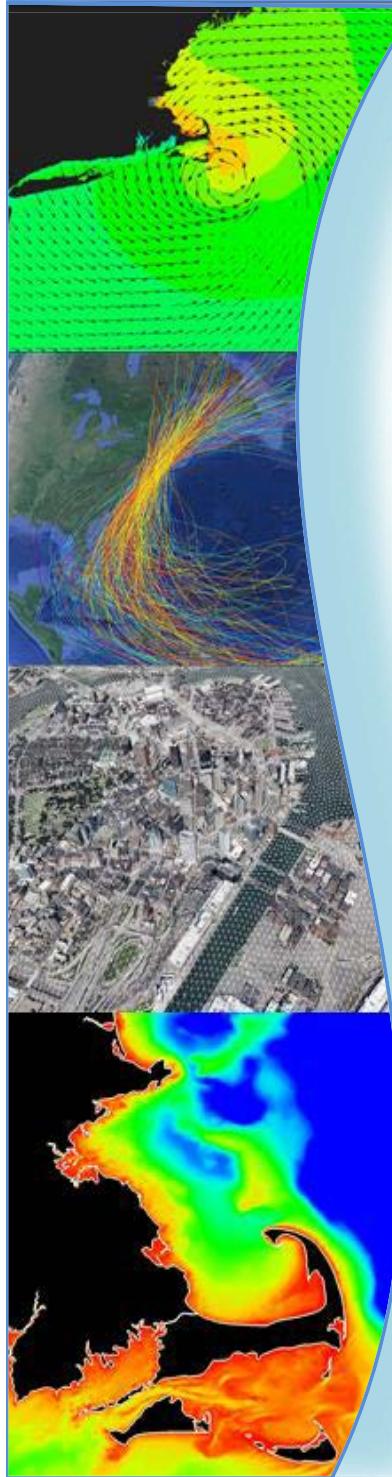
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<sup>4</sup> Dennis: Section 6.7 Special Provisions for Lifting Structures to New and Appropriate Elevations: (1) Notwithstanding the provisions of any other provisions to the Dennis By-law to the contrary, except as otherwise provided pursuant to paragraph (3) of this subsection, a person shall be allowed to lift an existing structure located in an area of Special Flood Hazard to a new and appropriate elevation, or constructing a staircase or other attendant structure necessitated by such racing without the need for Board of Appeals relief, provided, however, this exemption shall apply only to the minimum extent or degree necessary to allow the structure to meet the new and appropriate elevation with adequate means of ingress, egress and accommodation of typical basement facilities.

- A frequently mentioned measure for flood resilience is to require buildings be elevated above the FEMA defined BFE to provide freeboard. In some cases, corresponding exemptions from height limitations are also accommodated.
- Boston and Cambridge both recognize potential hardship to small residential users and have limited, or are contemplating, limiting the flood resilience requirements, beyond the state building code, to larger structures.
- Zoning for flood resilience may entail limited exemptions from GFA, Open Space, Height and Setback requirements for accommodation of flood resilience measures.
- Limits on basements in flood prone areas.
- For building or substantial alteration of landforms in a Floodplain District, some communities require a Special Permit, and as part of that Special Permit, a resiliency review is required.



*“According to the Cambridge Climate Change Vulnerability Assessment, which utilizes the Boston Harbor Flood Risk Model (BH-FRM), the AED [Amelia Earhart Dam] is likely to be flanked by 2045, and overtopped by 2055. The Department of Conservation and Recreation (DCR) is actively undertaking a Feasibility Analysis on raising and extending the AED and is pursuing this effort in coordination with regional resiliency effort. Figure 10 shows the mapping of the 1% Annual Flood depth projected throughout Arlington by the BH-FRM, which was the model used the Cambridge Climate Change Vulnerability Assessment.” Source: Weston & Sampson January 20, 2021 memo to the Arlington Land Trust.*



## MassDOT-FHWA Climate Resilience Pilot Project

### Modeling Overview and Frequently Asked Questions

#### Overview

The Massachusetts Department of Transportation (MassDOT) and the Federal Highway Administration (FHWA) have commissioned a pilot project to assess and improve the resiliency of the Central Artery and Tunnel System (CA/T) by analyzing its vulnerability to sea level rise and extreme weather events, investigating options for adaptation to the identified vulnerabilities, and establishing an emergency response plan for tunnel protection. A major component of the pilot project is a detailed modeling effort that simulates extreme weather events under both present and future climate conditions. The project is being managed by the MassDOT Highway Division Environmental Services Section and being executed by UMass-Boston, Woods Hole Group, Inc. and University of New Hampshire. The MassDOT Boston Harbor Flood Risk Model (BH-FRM) model is being developed and used to determine inundation risk and flooding pathways; and to simulate the dynamic nature of flooding in the City of Boston that serve as flood pathways affecting the CA/T. BH-FRM is an advanced model that simulates the effects of tides, storm surge, wind, waves, wave setup, river discharge, sea level rise, and future climate change scenarios.

#### FAQ

***Are the results of the BH-FRM applicable to the entire City of Boston and City of Cambridge?***

Yes, flood risks results will be available throughout the City of Boston and Cambridge. All parts of the City of Boston and Cambridge that are at an elevation low enough for storm surge-induced flooding to occur are included.

***Why does the BH-FRM model include detailed results in the City of Cambridge?***

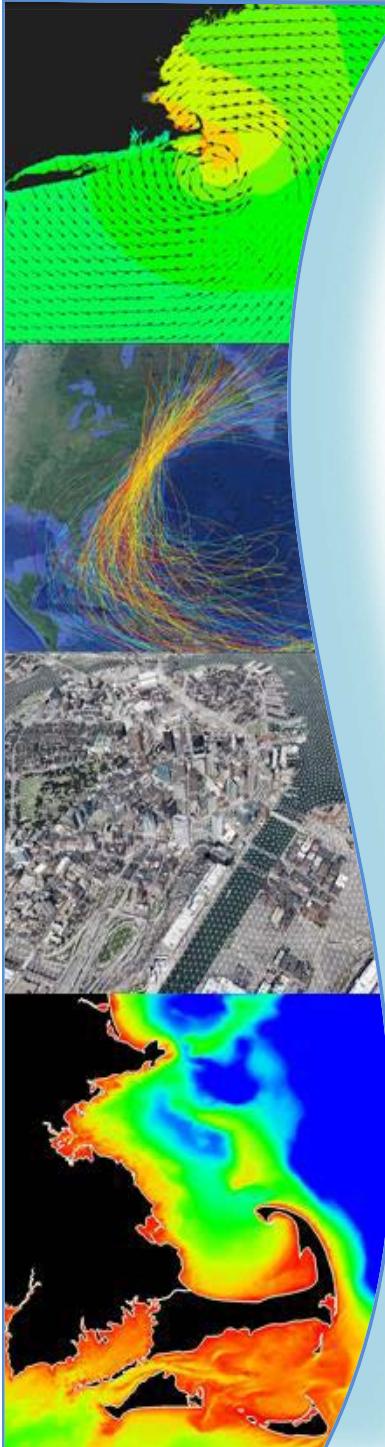
The City of Cambridge provided additional funding to extend the focus area of the BH-FRM model.

***Are the BH-FRM results applicable to a specific building or structure located in Boston or Cambridge?***

Yes.

***Are the results of the BH-FRM applicable to the areas outside the Boston and Cambridge?***

BH-FRM provides information for adjacent areas in Massachusetts, as well as Rhode Island, New Hampshire, Maine, and Connecticut, but will not be able to identify risk associated with specific assets for locations outside of the focus area (Boston & Cambridge). However, the model can be extended to do so in the future.



## MassDOT Climate Change Adaptation Pilot Project

### Modeling Overview and Frequently Asked Questions

#### **What is the resolution of the BH-FRM model grid?**

BH-FRM uses an unstructured grid that allows for the grid resolution to vary across the model domain. In the BH-FRM focus area (Boston, Cambridge and Boston Harbor), the model resolution ranges from five to thirty meters for both inland areas and coastal waters. In areas beyond the focus area (Atlantic Ocean), the resolution increases to 100 to 500 meters. Most of the coastal areas in New England have a resolution between 50 to 100 meters.

#### **What is the complete extent of the BH-FRM model domain?**

The BH-FRM domain extends from the Gulf Coast to Newfoundland (see attached map).

#### **What is the specific extent of the BH-FRM and the detailed focus area?**

See the attached map.

#### **What types of storms does BH-FRM simulate?**

BH-FRM simulates storm surge induced flooding that could occur from both tropical (hurricanes) or extra-tropical (nor'easter) storm events. The model also includes climate-change induced increases in river discharge from precipitation and storm water run-off. A statistically robust approach is used to capture variations in storms.

#### **Does the BH-FRM include freshwater flooding?**

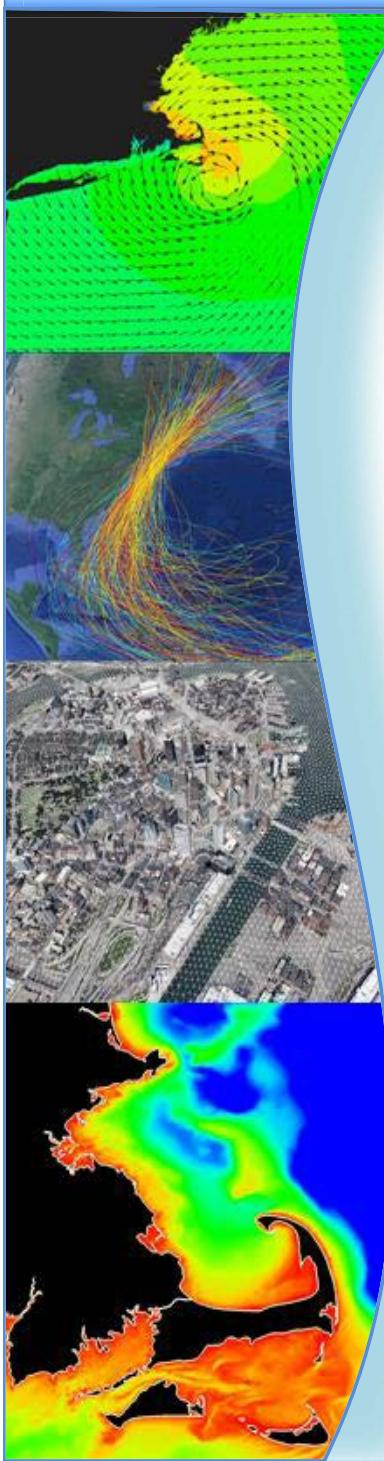
To some extent the Charles and Mystic Rivers are incorporated into the BH-FRM because the freshwater outflows of the rivers interact with storm-surge induced flooding. However, freshwater storm flooding events that have no ocean-based component are not included in the risk analysis (for example, while the flow contribution of precipitation in the upper reaches of the Mystic to flooding in the coastal area are included, the local freshwater flooding in the upper Mystic is not).

#### **Are the Charles River Dam and Amelia Earhart Dam included in the model?**

Yes.

#### **What makes BH-FRM more accurate than other inundation models and flood maps that have been created for the region?**

The BH-FRM is a more accurate representation of flooding risk because it is (1) a dynamic model that includes the critical processes associated with storm induced flooding (winds, waves, wave-setup, storm surge, river discharge, etc.), (2) calibrated to historical storm events with observed high water data, (3) high enough resolution to capture flood pathways in the complex urban topography of Boston and Cambridge, and (4) able to capture the net effect of varying storm types, magnitudes, and parameters.



## MassDOT Climate Change Adaptation Pilot Project

**Modeling Overview and Frequently Asked Questions**

***How do BH-FRM results relate to other existing Sea Level Rise inundation maps (e.g., The Boston Harbor Association flood maps)?***

BH-FRM is a dynamic model that includes relevant flooding processes and their interaction. The model includes the dynamic effects of tides, storm surge, land effects, winds, waves, wave setup, etc. Results also include changes in climate to assess variations in storm intensity, etc. These processes can result in significant differences in the magnitude and extent of flooding throughout a region. For example, flooding caused by tropical storm events (such as Hurricane Sandy) are typically not well represented by non-dynamic models based on the expected water surface elevation overlain on land elevation. Flood mapping approaches, such as the TBHA bathtub flood maps, do not include the influence of the storm track, winds, and waves.

***How do BH-FRM results relate/compare to the recently released FEMA Preliminary Flood Insurance Rate Maps (FIRMs)?***

BH-FRM results are focused on present and future flooding projections, while FEMA results estimate present flood risk based on historical events. The methods used to produce the FIRMs are also substantially different. BH-FRM is also being used to assess present day conditions, simulate historic storm events, and can potentially provide improved input to the FEMA models and mapping.

***Will the BH-FRM model show flooding propagating down streets and through buildings?***

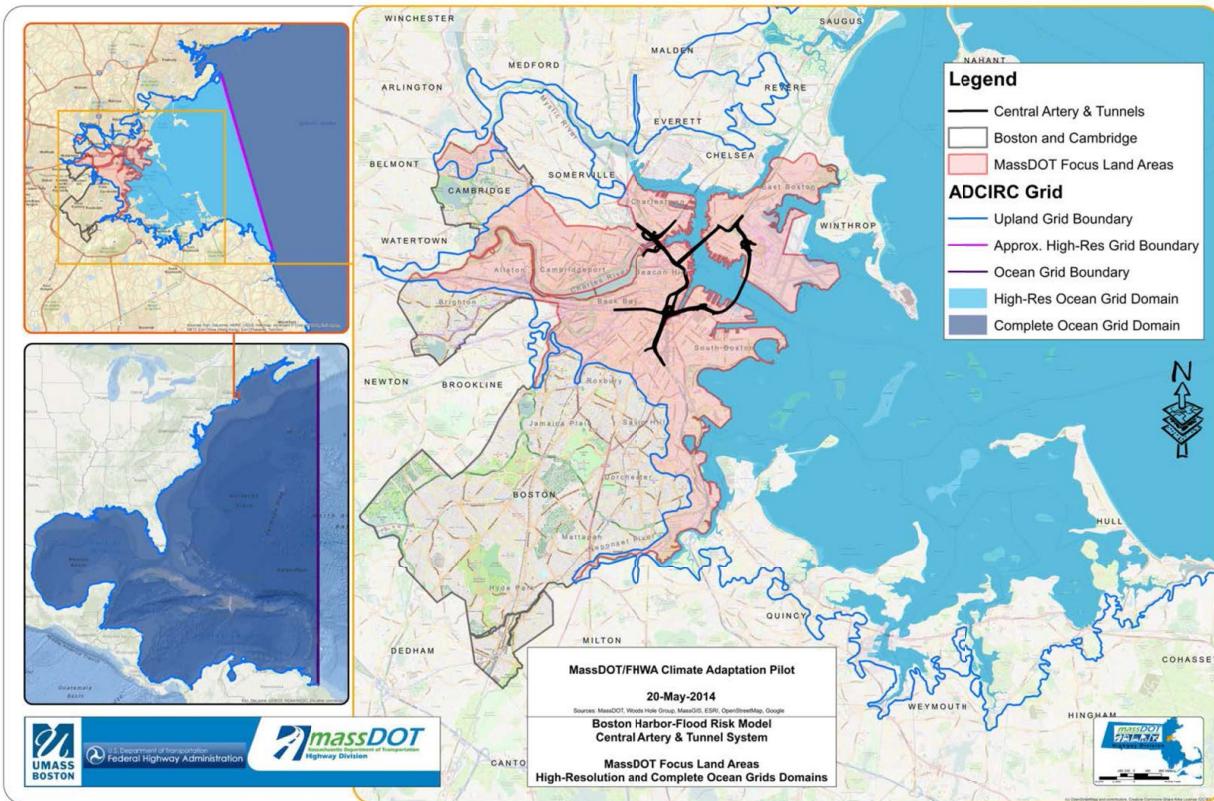
Flood risk and water depths will be available for individual buildings and streets with this model. However, the model does not currently intend to show flooding into buildings or the detailed flow down every street. An extension to the model is being considered to provide visualizations of flood propagation down streets and flood pathways, but it will not model flooding into structures.

***Will the BH-FRM results of flooding risk be publicly available?***

Yes. Full model results for the focus area (Boston and Cambridge) will be publicly available.

***What is needed to extend the BH-FRM focus area to my town/area?***

To extend the BH-FRM into any specific area requires additional grid development and may also require additional climate input conditions determined by your project requirements.



## Resilience Zoning Mechanisms

Jim Newman, Linnean Solutions

### **Residential Apartment Commercial zoning – Toronto, CA**

<https://www.toronto.ca/community-people/community-partners/apartment-building-operators/residential-apartment-commercial-zoning/>

*From the resource:*

“Residential Apartment Commercial (RAC) zoning allows small-scale non-residential uses, such as food markets, shops, small business, classes, community facilities and other initiatives, on more than 400 apartment buildings sites that were previously residential-only. [Toronto City Council adopted the bylaw](#) in 2013 and the Ontario Municipal Board approved the new zone in 2016.

Allowing for a wider range of uses in apartment tower neighbourhoods has a number of benefits, such as:

- convenient and walkable access to local shops, services and amenities for residents.
- opportunities to engage in small-scale enterprises for residents and the community.
- new service offerings to current and potential residents and a new potential revenue stream for property owners.
- more animated, safer and inviting places for everyone!

The Tower Renewal Program is supporting property owners, community groups, residents and others interested in implementing projects using the new RAC zone. If you have any questions about the zone, partnerships and implementation, email us at [tower@toronto.ca](mailto:tower@toronto.ca).

### **Zoning for Flood Resiliency – New York City, NY**

<https://www1.nyc.gov/site/planning/plans/flood-resilience-zoning-text-update/flood-resilience-zoning-text-update.page>

*From the resource (two-page summary of flood text saved on server):*

“The Flood Resilience Zoning Text (the “Flood Text”) is one part of a wide range of efforts by the City to recover from Hurricane Sandy, promote rebuilding, and increase the city’s resilience to climate-related events, including coastal flooding and storm surge.

The Flood Text encourages flood-resilient building construction throughout designated floodplains by removing regulatory barriers that hinder or prevent the reconstruction of storm-damaged properties. It also enables new and existing buildings to comply with new, higher flood elevations issued by the Federal Emergency Management Agency (FEMA), and to comply with new requirements in the New York City Building Code (“Building Code”).”

### **Norfolk Zoning Ordinance Rewrite – Norfolk, VA**

<https://www.norfolk.gov/DocumentCenter/View/35581>

*From the resource:*

“The City of Norfolk, Virginia adopted a new zoning ordinance to enhance flood resilience and direct new more intense development to higher ground; the ordinance was adopted on January 23, 2018 and became effective on March 1, 2018. The ordinance establishes a Coastal Resilience Overlay (CRO) zone, where new development and redevelopment will have to comply with new flood resilience requirements, and an Upland Resilience Overlay (URO), designed to encourage new development in areas of the city with lower risk of flooding.

The zoning ordinances includes the following innovative practices for fostering more flood resilient urban development:

- **Freeboard** - The ordinance requires that construction in the 100-year floodplain be elevated at least 3 feet above the 100-year base flood elevation, and construction in the 500-year (0.2% chance) floodplain, to be elevated or floodproofed to 1.5 feet above the 500-year flood elevation.
- **Coastal Resilience Overlay** - In the CRO zone, additional requirements include the use of permeable surfaces on new parking spaces and stormwater infiltration requirements.
- **Upland Resilience Overlay** - In an URO zone, applied to areas outside of flood hazard zones, the ordinance includes policies aimed to target redevelopment to create transit-oriented, walkable, and bikeable neighborhoods.
- **Resilience Quotient System** - The ordinance also adds a new resilience quotient system, where developers earn points for adopting different resilient measures that promote flood risk reduction, stormwater management, and energy resilience, among other practices. New developments are required to meet different resilience point values based on the development type (e.g., residential, non-residential, mixed-use) and development size, unless the developer opts to meet specified standards for elevation and drainage... “

#### **Planning and Zoning for Resiliency – Hartford, CT**

<https://aap.cornell.edu/news-events/sara-bronin-planning-and-zoning-resiliency-hartford-example>

*From the resource:*

“Once the richest city in the country, Hartford has become a textbook example of urban disinvestment in post-industrial America. Despite its difficulties, Hartford is positioning itself as a model for urban sustainability and environmental stewardship through progressive planning and zoning initiatives. With the implementation of an innovative form-based zoning code, the City of Hartford is seeking to boost economic growth while preserving historic character, encouraging smart growth, and promoting public health and sustainability. Additionally, the city has built on the momentum of its zoning overhaul by convening a group of local stakeholders as the Hartford Climate Stewardship Council and adopting Hartford’s first-ever Climate Action Plan.”

*See article for more specifics of zoning code:*

<https://greencitiesbluewaters.wordpress.com/2016/02/16/hartfords-new-zoning-code-an-environmental-win/>

#### **Byblos Zoning Plan to Regulate Urban Sprawl – Byblos, Lebanon**

[http://www.100resilientcities.org/wp-content/uploads/2017/07/Byblos-ResStrat\\_Eng\\_Onlineversion.compressed.pdf](http://www.100resilientcities.org/wp-content/uploads/2017/07/Byblos-ResStrat_Eng_Onlineversion.compressed.pdf)

*From the resource:*

“Preparing a municipal zoning plan to regulate and limit urban sprawl and unplanned building developments, and protect the surrounding environment. Areas with special cultural and environmental importance such as the river corridor, the archaeological sites, and the railway corridor should be given special status, together with areas suitable for increased density of development. Alignment with the proposed mobility plan for the city to redirect urban sprawl and growth is crucial.”